

App. No. 10/719,629

Reply to Office action of March 9, 2006

Amendments to the Claims:

1. (currently amended) A protective barrier coating for a silicon based substrate, comprising;

a diffusion barrier coating formed on a substrate, said diffusion barrier coating inhibiting or preventing diffusion of cations from the substrate to an oxidation coating;

an oxidation barrier coating formed on the diffusion barrier coating, said oxidation barrier coating inhibiting or preventing the oxidation of the substrate; and

an environmental barrier coating formed on the oxidation barrier coating, said environmental barrier coating inhibiting or preventing water vapor from reacting with the oxidation barrier coating to form volatile  $\text{Si}(\text{OH})_4$  and;

a thermal barrier coating formed on the environmental barrier coating, said thermal barrier coating limiting heat transfer from an environment to said environmental barrier coating and shielding the environmental barrier coating from erosion and corrosive dust,

wherein one or both of the oxidation barrier coating and the environmental barrier coating comprises a metal disilicate.

2. (original) The protective barrier coating of claim 1, wherein said diffusion barrier coating is made of an over 99 mol % pure compound selected from the group consisting of  $\text{SiC}$ ,  $\text{Si}_3\text{N}_4$ , and  $\text{Si}_2\text{ON}_2$

3. (original) The protective barrier coating of claim 1, wherein said oxidation barrier coating is made of a disilicate selected from the group consisting of  $\text{Sc}_2\text{Si}_2\text{O}_7$ ,  $\text{Y}_2\text{Si}_2\text{O}_7$ , and  $\text{Yb}_2\text{Si}_2\text{O}_7$ .

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4. (original) The protective barrier coating of claim 1, wherein said oxidation barrier coating is made of a inner layer of  $\text{Si}_2\text{ON}_2$  and an outer layer of disilicate selected from the group consisting of  $\text{Sc}_2\text{Si}_2\text{O}_7$ ,  $\text{Y}_2\text{Si}_2\text{O}_7$ , and  $\text{Yb}_2\text{Si}_2\text{O}_7$ .

5. (original) The protective barrier coating of claim 1, wherein the diffusion barrier layer is of  $\text{SiO}_2$  and the oxidation barrier layer is of disilicate selected from the group consisting of  $\text{Sc}_2\text{Si}_2\text{O}_7$ ,  $\text{Y}_2\text{Si}_2\text{O}_7$ , and  $\text{Yb}_2\text{Si}_2\text{O}_7$ .

6. (original) The protective barrier coating of claim 1, wherein said environmental barrier coating includes a metallic disilicate and up to 10 weight % of a metallic oxide and monosilicate wherein the metal is one selected from the group of scandium, yttrium and ytterbium.

7. (original) The protective barrier coating of claim 1, wherein said environmental barrier coating includes tantalum oxide alloyed with one oxide selected from the group of lanthanum oxide and alumina.

8. (currently amended) The protective barrier coating of claim 1, wherein said thermal barrier coating includes ~~zirconia~~ zirconium oxide alloyed with yttrium oxide..

9. (original) The protective barrier coating of claim 1, wherein at least one interface between said diffusion barrier coating, oxidation barrier coating, environmental barrier coating and thermal barrier coating is graded to allow a gradual transition.

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10. (original) A protective barrier coating for a silicon based substrate, comprising;

an oxidation barrier coating formed on the substrate, said oxidation barrier coating comprising a metallic disilicate;

an environmental barrier coating formed on the oxidation barrier coating, said environmental barrier coating comprising a compound selected from the group consisting of a tantalum oxide alloy and a scandium silicate mixture.

11. (original) The barrier coating of claim 10, wherein said metallic disilicate is at least one silicate selected from the group consisting of scandium, yttrium and ytterbia.

12. (original) The barrier coating of claim 11, wherein said environmental barrier coating includes a metallic disilicate and up to 10 weight % of a metallic oxide or monosilicate of the same metal as the disilicate selected from the group of scandium, yttrium and ytterbium.

13. (original) The barrier coating of claim 10, wherein the oxidation barrier layer has a duplex structure consisting of an inner layer of  $\text{Si}_2\text{ON}_2$  disposed between the silicon nitride substrate and the outer metallic disilicate layer.

14. (original) The barrier coating of claim 10, wherein said tantalum oxide alloy is alloyed with an oxide, wherein the oxide is selected from one of the group consisting of about 4 to 7 mol% lanthanum oxide and about 1-3 mol % alumina.

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15. (original) The barrier coating of claim 10, wherein said metallic silicate is deposited on said substrate by at least one of the steps selected from the group consisting of spraying and dipping the substrate in a water based slurry of at least one of the disilicates selected from the group consisting of scandium, yttrium and ytterbium.

16. (original) The barrier coating of claim 10, wherein the protective barrier coating includes a thermal barrier coating formed on the environmental coating, said thermal coating comprising stabilized zirconia and wherein said stabilized zirconia is yttria stabilized zirconia.

17. (original) A combination silicon based substrate and a barrier coating comprising:  
the silicon based substrate being selected from the group consisting of silicon carbide and silicon nitride,

a diffusion barrier coating in the range of 99 to 100% pure  $\text{Si}_3\text{N}_4$ ,  $\text{SiC}$  or  $\text{Si}_2\text{ON}_2$  on said substrate;

an oxidation barrier coating formed on the diffusion coating, said oxidation coating comprising a metallic disilicate;

an environmental barrier coating formed on the oxidation coating, said environmental coating made of a compound selected from the group consisting of a tantalum oxide alloy and scandium disilicate.

18. (original) The combination of claim 17, wherein the oxidation barrier layer has a duplex structure consisting of an inner layer of  $\text{Si}_2\text{ON}_2$  disposed between the substrate and an outer metallic disilicate layer, the maximum thickness of the  $\text{Si}_2\text{ON}_2$  layer is not greater than 40 microns.

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19. (original) The combination of claim 17, wherein said metallic disilicate is at least one silicate selected from the group consisting of scandium, yttrium and ytterbia and said metallic silicate can contain up to 10 weight % of a metal oxide wherein said metallic silicate and said metallic oxide have the same base metal.

20. (original) The combination of claim 17, wherein said tantalum oxide alloy is alloyed with an oxide wherein the oxide is selected from the group consisting of lanthanum oxide and alumina.

21. (original) The combination of claim 17, wherein the protective barrier coating includes a thermal barrier coating formed on the environmental coating, said thermal barrier coating comprising stabilized zirconia.

22. (original) A protective barrier coating for a silicon based substrate comprising;

a diffusion barrier coating formed on the substrate;

an oxidation barrier coating of scandium disilicate formed on the diffusion barrier coating and;

an environmental barrier coating formed on the oxidation barrier coating and comprising one of a tantalum oxide alloy and a mixture of scandium disilicate, scandium monosilicate and scandium oxide and;

the protective barrier coating also comprises a thermal barrier coating formed on the environmental barrier coating and comprising stabilized zirconia.

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23. (original) The protective barrier coating of claim 22, wherein said diffusion coating is in a range of about 0.5 to 10 micron thick layer of over 99% pure silicon based material selected from the group consisting of  $\text{Si}_3\text{N}_4$ ,  $\text{SiC}$  or  $\text{Si}_2\text{ON}_2$ .

24. (original) The protective barrier of claim 22, wherein said oxidation barrier coating has a duplex structure consisting of an inner layer of  $\text{Si}_2\text{ON}_2$  disposed between the substrate and the outer metallic disilicate layer.

25. (original) The protective barrier of claim 22, wherein said oxidation barrier coating is in the range of not greater than 40 microns thick.

26. (original) The protective barrier of claim 22, wherein said oxidation barrier coating is in the range of not greater than 20 microns thick.

27. (original) The protective barrier of claim 22, wherein said tantalum oxide alloy includes a metallic oxide selected from the group consisting of lanthanum oxide in the range of 3 to 10 mol % and alumina in the range of 1-3 mol %.

28. (original) The protective barrier of claim 22, wherein said mixture of scandium disilicate, scandium monosilicate and scandium oxide includes scandium disilicate in a range of 60 to 100 weight percent.

29. (original) The protective barrier of claim 22, wherein said environmental barrier coating is in a range of 5 to 50 microns thick.

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30. (original) The protective barrier of claim 22, wherein said thermal barrier coating includes stabilized zirconia in a range of 10 to 2000 microns thick.

31. (original) The protective barrier of claim 28, wherein said thermal barrier coating includes stabilized zirconia in a range of 10 to 40 microns thick.

32. (original) The protective barrier of claim 22, wherein said diffusion barrier coating is deposited by physical vapor deposition.

33. (original) The protective barrier of claim 22, wherein said diffusion barrier coating is deposited by chemical vapor deposition.

34. (original) The protective barrier of claim 22, wherein said diffusion barrier coating consists of one of the silicon compounds selected from the group consisting of SiC or Si<sub>3</sub>N<sub>4</sub>, in the range of 99 to 100% pure.

35. (original) The protective barrier of claim 22, wherein said diffusion barrier coating, said oxidation barrier coating, said environmental barrier coating and said thermal barrier coating have a combined thickness in the range of 30-100 microns.

36 to 71. (canceled).